Space Weather Technical Forecast

Issued on Thursday, 31 March 2022 at 13:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares likely throughout. Slight chance of further S1 or above solar radiation storms. G1-G2/Minor-Moderate geomagnetic storms expected Days 1 and 2 (31 March and 1 April), with Chance of a G3/Strong storm.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been at High levels over the past 24 hours, with an X1.3 class flare at 30/1737UTC, which originated from AR2975, subsequently resulting in R2-R3 radio blackouts, peaking at 30/1746UTC. The X1.3 flare from AR2975 produced a coronal mass ejection (CME), and this may be Earth-directed.
There are currently four numbered sunspots on the visible disc, with AR2976 in the northwest quadrant, currently the largest sunspot, but remains stable. Meanwhile, AR2975 (also in the NW quadrant) remains magnetically complex and continues to develop, with the presence of delta spots, and produced the X-class flare. AR2978 continues to rotate across the SE quadrant, with some development of the intermediate spots. The remaining sunspots are relatively small and magnetically simple.

Solar Wind / Geomagnetic Activity: Solar wind speeds started the period mostly Slow becoming slightly elevated by around 30/2100 UTC, and then on arrival of a coronal mass ejection (CME) around 31/0200 UTC became elevated with a peak of 604 km/s at 31/0616 UTC. The density was near average to start becoming above average around 31/0130 UTC with a peak of 51 ppcc at 31/0258 UTC. The strength of the IMF, Bt, started weak and below 6nT before increasing moderate to strong on arrival of the CME to peak at 20 nT around 31/0335 UTC. The north-south component, Bz, was weak initially before becoming Moderate +12 to -13 nT during onset of the CME. The Phi angle started the period positive (away from the sun) to become negative around 30/1800 UTC and then became variable in orientation from 30/200 UTC. Geomagnetic activity started the period at Quiet levels (Kp1-2), with an increase to reach Active to minor storm (G1) levels (Kp 4-5) from around midnight.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) measured at GOES-16 showed an increase following the strong flare to reach minor storm (S1) levels for a short period around 31/0600 UTC. The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO was at background to moderate levels, with a peak of 243pfu at 30/1540 UTC. The observed fluence at 31/0001 UTC was 4.38e6 integrated pfu with little change since that time.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate, with further M-class flares likely, and a slight chance (15%) of another X-class flare, this most likely emanating from AR2975.

Solar Wind / Geomagnetic Activity: The 28th March CME(s), arrived in the early hours of 31

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March. The currently elevated solar winds and enhanced geomagnetic activity are anticipated to continue into Day 2 (1 April) before gradually weakening into Day 3 (2 April). However a further CME is forecast to give a solar wind and geomagnetic enhancement early on Day 3 (2 April) but confidence is currently low for detail. A fast wind from a coronal hole(s) influence is also forecast by Day 3 (2 April).
Active to G1-G2/Minor-Moderate storm periods are expected on Day 1 (31 March), with the Chance (30%) of a G3/Strong Storm, and perhaps a Slight Chance (10%) of a G4/Severe Storm. Disturbed geomagnetic conditions are expected to continue into Day 2 (1st April), with the arrival of a CME from the X-Class flare on 30 March which will probably give a glancing blow to Earth, before gradually easing into Day 3 (2nd April). However, geomagnetic activity may remain Unsettled to Active Days 3 and 4 (2nd and 3rd April) due to a possible fast wind from a coronal hole(s) influence.

Energetic Particles / Solar Radiation: The continued activity of AR2975 in particular gives the slight chance of further potential enhancements above the S1 threshold during the period.
A flat trend is expected at first in the high energy (greater than 2 MeV) electron flux. However, from Day 1 (31st March) confidence becomes low with the CME arrivals likely to at least temporarily reduce flux levels. Thereafter, some erratic fluctuation is likely, but with a possible eventual rise towards the end of the period. The associated 24 hour fluence is likely to remain below the Active (1e8 integrated pfu) threshold for much of the period.

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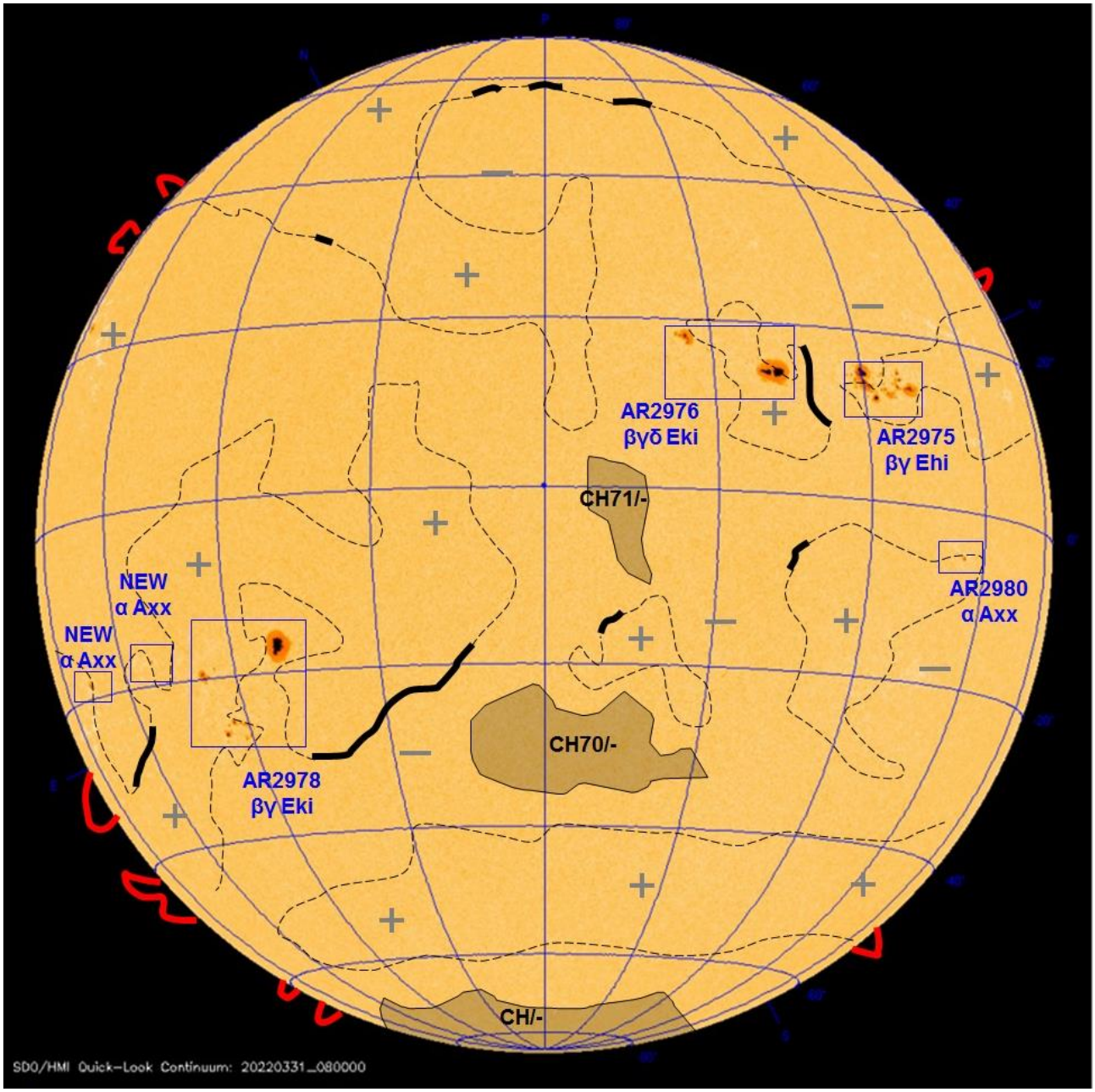
Figure 1. Solar Analysis Valid 0800 UTC, 31 March 2022.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Active to G1-G2/Minor-Moderate storm periods are expected on Day 1 (31 March), with the Chance (30%) of a G3/Strong Storm, and perhaps a Slight Chance (10%) of a G4/Severe Storm. Disturbed geomagnetic conditions are expected to continue into Day 2 (1st April), with the arrival of a CME from the X-Class flare on 30 March which will probably give a glancing blow to Earth, before gradually easing into Day 3 (2nd April). However, geomagnetic activity may remain Unsettled to Active Days 3 and 4 (2nd and 3rd April) due to a possible fast wind from a coronal hole(s) influence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	80	60	30	10
Strong	G3	No	30	30	5	1
Severe	G4	No	10	10	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
30/2315	Halo	2975	NW quadrant	700	02/1800 UTC	Limited shock possible. Mot of material passes Earth with low confidenc

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Met Office Space Weather Technical Forecast

Radio Blackouts - X-Ray Flares:

Solar activity is currently at High levels, with an X1.3 class flare, peaking at 30/1737UTC, and originating from AR2975 in the northwest quadrant. There are currently four numbered sunspot regions on the visible disc. AR2975 (NW quadrant) remains magnetically complex and continues to develop, with coalescence of some of the intermediate spots and an increase in length. At least two delta spots have been evident. This region produced the aforementioned X-class flare and CME. AR2976 also in the northwest quadrant is currently the largest sunspot, although remains stable. AR2978 continues to rotate across the SE quadrant. The large lead spot unchanged, with some increase in its spots in the southeast of the region. AR2980 (Hsx/Alpha) in the southwest is small and remains stable. Two NEW regions have emerged to the east of AR2978 near the limb, these will be monitored for any further development.
Solar activity is expected to be Moderate to Low, but with the chance (50%) of further M-class flares, and a slight chance (10%) of an X-class flare, mainly from AR2975.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	Yes	10	10	10	10

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES-16 was close to the S1 boundary and is now showing a slow decline. The continued activity of AR2975 in particular gives the slight chance of further potential enhancements above the S1 threshold during the period.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	Yes	20	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux, as observed by GOES-16 at GEO, has been at background to moderate levels, with a peak of 243pfu at 30/1540 UTC. A flat trend is expected at first. However, from Day 1 (31st March) confidence becomes low, due the the impact from the incoming CME material affecting Earth, and this is likely to at least temporarily reduce flux levels. Thereafter, some erratic fluctuation is likely, but with a possible eventual rise towards the end of the period.

The 24 hour fluence is likely to remain below the Active (1e8 integrated pfu) threshold for much of the period. REFM is considered to be giving reasonable guidance in the short term with a flat trend, but will not reflect the anticipated CME influences from Day 1 (31st).

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	20	30	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	5	5

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